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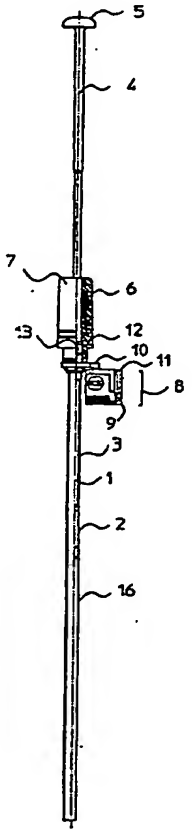
(57) Abstract

The antenna device of the present invention is intended for a portable equipment for transmitting and/or receiving radio signals. Said antenna device comprises a helical antenna (6) substantially having the characteristics of a half-wave antenna, a half-wave antenna (1), and an impedance transformer (8). Said helical antenna (6), said half-wave antenna (1), and said impedance transformer (8) are intercouplable so that either said helical antenna (6) alone is coupled to said impedance transformer (8) or said helical antenna (6) and said half-wave antenna (1) are coupled in parallel to said impedance transformer (8) in order to form two different working antenna functions.



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AN ANTENNA DEVICE FOR PORTABLE EQUIPMENT

The invention relates to an antenna device for portable equipment, particularly for hand portable telephones.

Antennas for mobile telephones may be divided into two main groups, quarter-wave and half-wave antennas, although types somewhere between and outside these may occur.

Characteristics of a quarter-wave antenna are:

- the length of its actively radiating portion is one quarter of a wavelength (portion length approximately 8 cm at 900 MHz),
- its feeding connection impedance is low, which allows its direct connection to the 50 Ohm of the telephone, without impedance transformation,
- due to its short length a 900 MHz telephone user will not consider it disturbing,
- it is dependent on a ground plane for its function.

Characteristics of a half-wave length antenna are:

- the length of its actively radiating portion is one half of a wavelength (portion length approximately 16 cm at 900 MHz),
- its feeding connection impedance is high, which requires impedance transformation to the 50 Ohm of the telephone,
- it is unsuitable to small telephone due to its total length of 18 - 20 cm including a connector,
- it is independent of a ground plane for its function.

In the specification and claims below the terms half-wave antenna and quarter-wave antenna refer to antennas having substantially the above characteristics, respectively.

One disadvantage in using the quarter-wave antenna, which is

dependent on a ground plane, is that the ground plane offered in hand portable telephone is in most cases smaller than one wavelength in a radius from the feeding point of the antenna. As a result, the ground plane becomes resonant and, consequently, it must be tuned to the antenna for optimal performance. Moreover, the ground plane characteristics change (and so the antenna performance) depending on whether the telephone is placed freely, whether the telephone (the ground plane) is held with the hand, whether the user is perspiring, whether the telephone is moved to the ear etc.

Another disadvantage in using a quarter-wave antenna for a hand portable telephone is, in fact, its small length. This causes the antenna, while in call position, to be strongly screened in a substantial angle sector by the head of the user.

In spite of the above mentioned disadvantages, the most common antenna for hand portable telephones is a quarter-wave length antenna, since a small antenna is needed to regard the telephone as hand portable or a pocket telephone. Recently, a type of hand portable telephone has appeared, which are provided with extendable half-wave antennas. This is an acceptable solution from the handling point of view, since the antenna requires a small space in the retracted position. The problem in this case is that the antenna function is so poor in the retracted position that it might be difficult to receive an incoming call.

Another known type of mobile telephones employs in combination a considerably more compact helical antenna of quarter-wave type as an antenna for receiving an incoming call, and a half-wave antenna which is extended in call position. However, this arrangement is unsatisfactory due to the ground plane dependence of the helical antenna and the switching between the helical antenna and the half-wave antenna being complicated, since only one antenna at the time may connected. Also, a

helical antenna has a lower degree of efficiency than e.g. a rod antenna.

All the above mentioned disadvantages are overcome by an antenna device according to the present invention.

This new antenna device for portable equipment uses in combination a helical antenna of half-wave length type arranged outside of a main body of said portable equipment, an extendable half-wave antenna, and an impedance transformer. Therefore, no ground plane is required for the antenna function. Further, due to the sufficient length of the half-wave length antenna, the problem of the user's head screening the antenna is substantially reduced. Yet further, a very simple switching may be performed, since the helical antenna and half-wave length antenna may utilize the same impedance transformer. The half-wave length antenna, when in use, may even be connected parallel to the helical antenna due to impedance differences. According to the invention this possibility is utilized and, therefore, only a very simple switching device is required. The switching device may be operated by extending and retracting of the antenna.

In the retracted position (see Fig. 3a) the half-wave length antenna is neither galvanically nor capacitively coupled to the impedance transformer. In this position the antenna function consists of only the helical antenna, which is constantly coupled to the impedance transformer. In the retracted position at possible coupling the lower end is transformed with high impedance to the upper end, which minimized the influence.

In the extended position the helical antenna and the half-wave length antenna are connected in parallel to the impedance transformer. Since the impedance of the half-wave length antenna is small compared to the impedance of the helical antenna the antenna function in this position is substantially

the same as for a half-wave antenna.

Thus, with the described device one meets the demands of antenna size in order to consider the telephone as hand portable, antenna performance in call position, and the telephone accessibility for incoming calls, when the half-wave antenna is in its retracted position.

It is possible to obtain the above-described characteristics with either galvanical or non-galvanical coupling of RF-signals e.g. between the half-wave antenna and the helical antenna/the impedance transformer or between the helical antenna/ the half-wave antenna and the impedance transformer.

The invention will be described below in the form of two embodiments with reference to the attached drawings, wherein:
Fig. 1 is a view of an embodiment of the antenna device according to the invention.
Fig. 2 shows with separated components parts of the antenna device of Fig. 1.
Fig. 3a shows details of for instance a switching device of the antenna device of Fig. 1.
Fig. 3b, 3c are two views of details of for instance an impedance transformer of the antenna device of Fig. 1.
Fig. 4b, 4c show alternative ways of providing couplings between a helica antenna, a half-wave antenna, and an impedance transformer contained in an antenna device according to the present invention.

The antenna device according to a preferred embodiment, shown in Figs. 1, 2, 3a, and 3b, consists of three main components.

First a half-wave antenna 1 (rod antenna), the lower end 2 of which is bare to facilitate the galvanic coupling, while it is otherwise provided with an insulating case 3, and the upper end of which is attached to an upper part 4 made of insulating

material. Together the half-wave antenna 1 and the upper part 4 form an antenna rod, which is preferably provided with a knob 5 in its upper insulating end.

Secondly, a helical antenna 6 of half-wave length type, which is moulded into a casing 7 made of protective, insulating material, which in its lower end has a fastened sleeve 12 made of conducting material. The sleeve 12 is mechanically and galvanically coupled to the lower of the helical antenna 6 and contains an elastic contact part 13. The antenna rod 1 is movably arranged through the helical antenna 6, the casing 7, the sleeve 12 and the contact part 13.

The above mentioned parts are substantially symmetrically arranged with regard to the central length axis of the antenna rod.

Thirdly, an impedance transformer 8, which, for example, consists of an inductive component 9 mounted on a circuit board 11, the capacitance of which is tuned to the environment. The impedance transformer is provided with a coaxial cable 14 connected to the transceiver part of the telephone, and with a galvanic coupling to the sleeve 12 through a connection loop 10, the sleeve 12 is also a connection device to the hand portable telephone 15 for the antenna device. Preferably, a protective insulating tube 16 is attached on the underneath side of the sleeve 12, into which tube 16 the antenna rod travels when retracted through the sleeve 12.

It is also possible to couple non-galvanically in any combination RF-signals between the half-wave antenna and the helical antenna/the impedance transformer or between the helical antenna/ the half-wave antenna and the impedance transformer. The performance of the antena device may be substantially maintained in doing so.

According to the example shown in fig. 4a, a coupling is obtained between the sleeve 12 interconnected to the helical antenna and the impedance transformer arranged on the circuit board 11, by means of a conductive, flexible reed 45 connected to the impedance transformer and being in close contact with the lower part of the sleeve 12, said lower part being provided with a thin insulating layer 47. The coupling in this case is capacitive and the corresponding capacitance is inversely proportional to the thickness of the insulating layer 47 and directly proportional to the permitivity of the layer and to an area defining adjacent areas of the lower part of the sleeve 12 and the flexible reed, respectively. The desired capacitance of the coupling is obtained through an appropriate choice of the mentioned parameters. In the eqivalent circuit diagram the capacitor created according to the above is indicated by 46, the sleeve 12 by a block 42, and a connection to the impedance transformer by the point 43.

In mobile telephones transmitting and receiving takes place as well when no call is going on. In this case the antenna rod is completely retracted, so that its upper, non-conductive part 4 is located inside the helical antenna. When so the half-wave antenna is galvanically and substantially capacitively separated from the helical antenna 6, the latter effecting the total antenna function.

During a call, or when otherwise required with regard to antenna performance, the half-wave antenna is extended, its lower part 2 being galvanically or capacitively coupled, via the contact part 13, in parallel with the helical antenna 6, to the impedance transformer 8. Since the impedance of the half-wave antenna 1 is low compared to the impedance of the helical antenna 6, the antenna function in this case is substantially the same as of a half-wave antenna alone.

Thus, the coupling and decoupling of the half-wave antenna 1 is

effected by extending and retracting of the antenna rod 1, respectively. The extension of the antenna rod is limeted by lower part 2 of the half-wave antenna being stopped by the contact part 13 and the sleeve 13. The contact part 13 also serves as a mechanical locking mechanism of the antenna rod in its extended position, while its retracting movement is limited by e.g. the knob 5 or a bottom of the insulated tube 16.

According to the example shown in fig. 4b, a coupling may be obtained between the half-wave antenna 1, in its extended position, and the sleeve 12, through providing the lower end 2 of the half-wave antenna 1 with a thin insulating layer 40. The coupling in this case between the half-wave antenna 1 and the sleeve 12 is capacitive. The corresponding capacitance is inversely proportional to the thickness of the insulating layer 40 and directly proportional to the permitivity of the layer and to an area defining adjacent areas of the sleeve 12 and the lower part 2, respectively. Since a high capacitance is desirable for this coupling the parameters are selected accordingly. In the eqivalent circuit diagram the capacitor created according to the above is indicated by 41, the sleeve 12 by a block 42, the helical antenna and the half-wave antenna by the symbols 6 and 1, respectively, and a connection to the impedance transformer by the point 43.

CLAIMS

1. An antenna device of a portable equipment for transmitting and/or receiving of radio signals, said antenna device comprising a helical antenna (6) sustantially having the characteristics of a half-wave antenna, a half-wave antenna (1), and an impedance transformer (8), said helical antenna (6), said half-wave antenna (1), and said impedance transformer (8) being intercouplable in at least two different combinations constituting different working antenna functions, c h a r a c t e r i z e d in that, in order to form two different working antenna functions, either said helical antenna (6) alone is coupled to said impedance transformer (8) or said helical antenna (6) and said half-wave antenna (1) are coupled in parallel to said impedance transformer (8).

2. An antenna device as claimed in claim 1, c h a r a c t e r i z e d in that said antenna device is provided with a switching device (2, 12, 13), which to said impedance transformer (8) either couples galvanically said half-wave antenna (1) in parallel with said helical antenna (6) or decouples said half-wave antenna (1).

3. An antenna device as claimed in claim 1, c h a r a c t e r i z e d in that said antenna device is provided with a switching device (2, 12), which to said impedance transformer (8) either couples capacitively said half-wave antenna (1) in parallel with said helical antenna (6) or decouples said half-wave antenna (1).

4. An antenna device as claimed in any one of claims 1-3, c h a r a c t e r i z e d in that the characteristics of either the helical antenna (6) or the half-wave antenna (1) are utilized mainly, at different demands for antenna performance.

5. An antenna device as claimed in claim 2 or 3,

c h a r a c t e r i z e d in that said half-wave antenna (1) is extendable and retractable.

6. An antenna device as claimed in claim 5, c h a r a c t e r i z e d in that said half-wave antenna (1) is telescopically extendable and retractable.

7. An antenna device as claimed in claim 2, 3, or 5, c h a r a c t e r i z e d in that said half-wave antenna (1) is provided with a switching device (2, 12, 13) operative to couple said half-wave antenna (1) when being extended and to decouple said half-wave antenna (1) when being retracted.

8. An antenna device as claimed in claim 7, c h a r a c t e r i z e d in that said swithing device (2, 12, 13) also serves as a mechanical locking mechanism of the half-wave antenna (1) in its extended position.

9. An antenna device as claimed in claim 7 or 8, c h a r a c t e r i z e d in that said swithing device consists of a lower part (2) of said half-wave antenna, a sleeve (12) coupled to said helical antenna (6) and to said impedance transformer (8), and, in case of galvanical coupling, a contact part (13) interconnecting said lower part (2) and said sleeve (12).

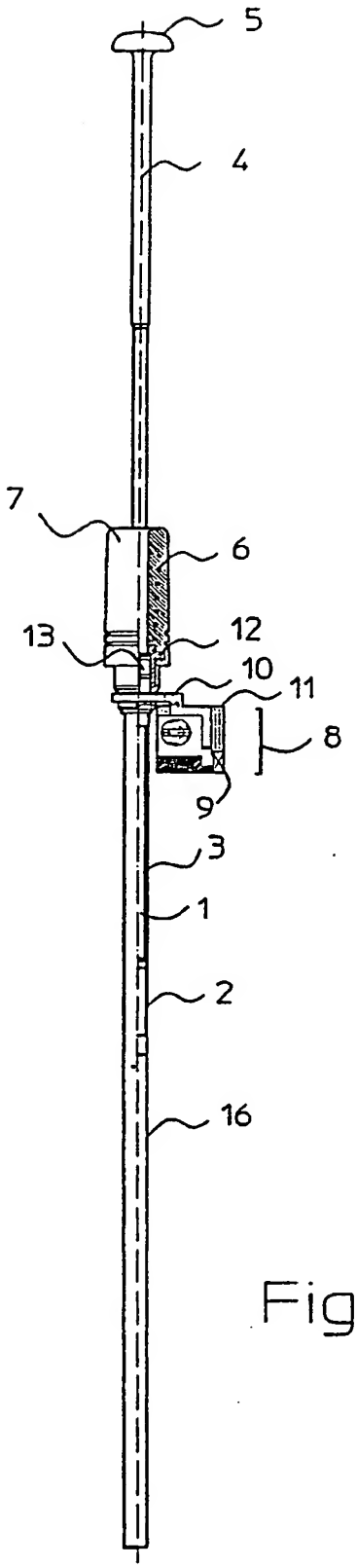

Fig.1

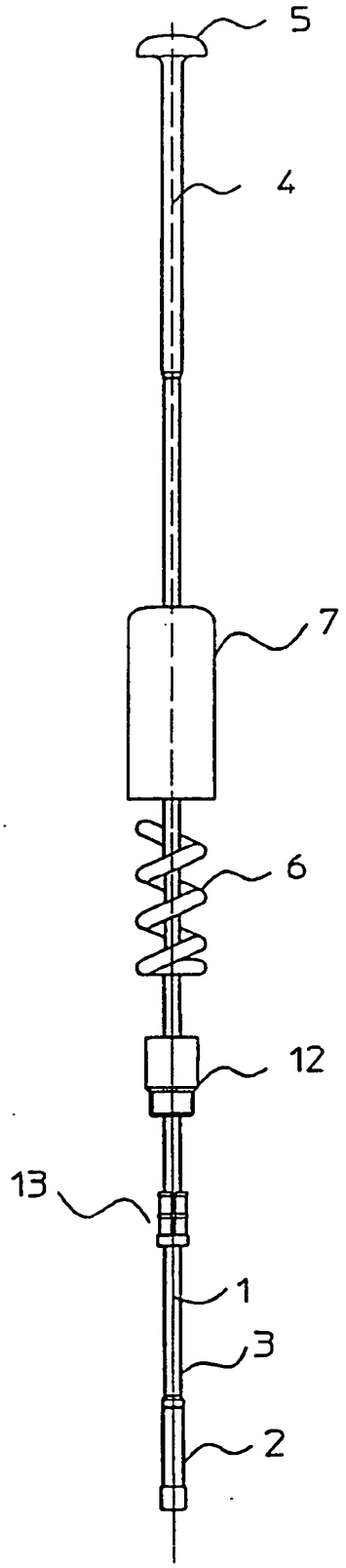

Fig.2

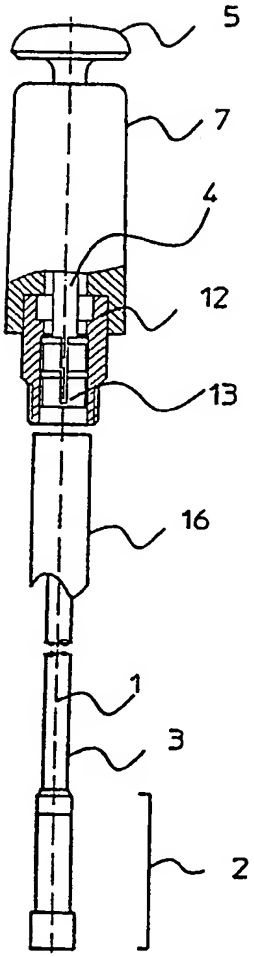

Fig.3a

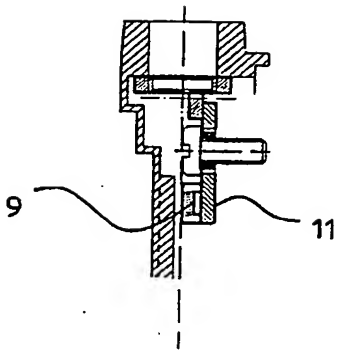

Fig.3b

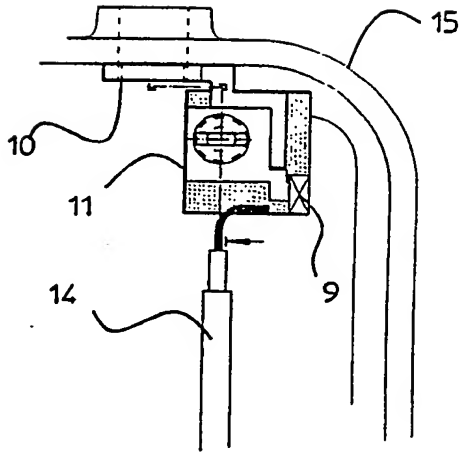

Fig.3c

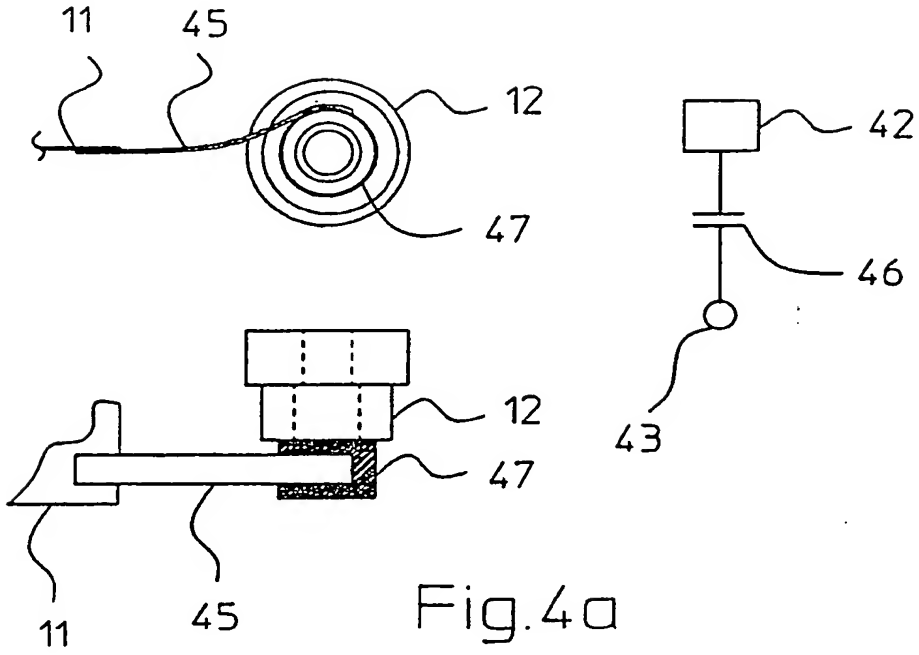

Fig.4a

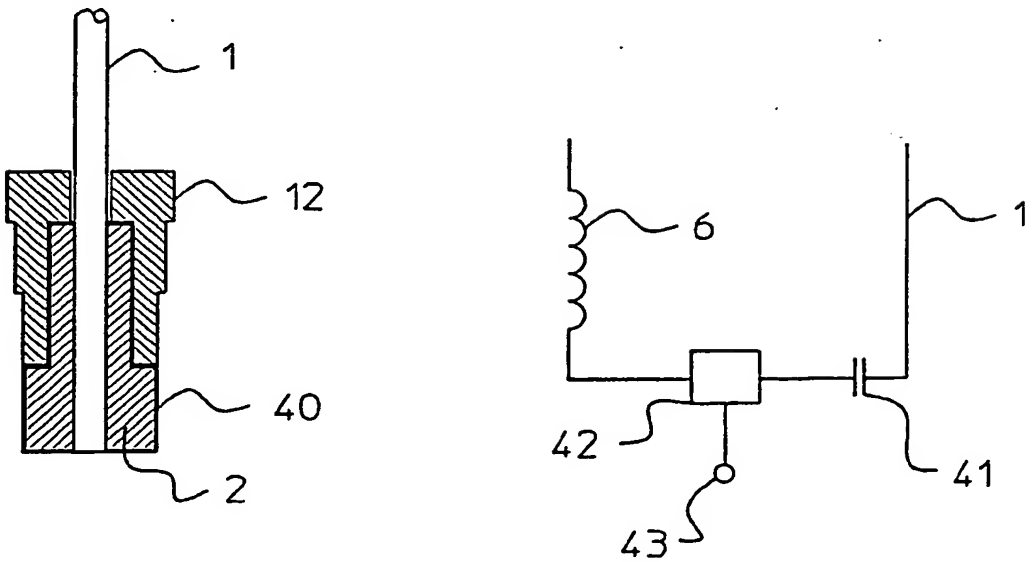

Fig.4b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 93/00886

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: H01Q 1/24, H01Q 9/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: H01Q, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4868576 (ROBERT M. JOHNSON JR.), 19 Sept 1989 (19.09.89), column 2, line 39 - column 3, line 59, figure 1 --	1,3-9
A	US, A, 4121218 (JAMES STUART IRWIN ET AL), 17 October 1978 (17.10.78), column 2, line 28 - column 4, line 10 --	1,3-9
A	EP, A2, 0467822 (GALTRONICS LTD), 22 January 1992 (22.01.92), see the whole document --	1,4

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/11/93

International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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